EVALUATION OF THE USE OF ELECTRICITY FOR PREDATOR REMOVAL AT THE TRACY FISH COLLECTION FACILITY

Investigators

Connie Svoboda
Hydraulic Engineer
Hydraulic Investigations and Laboratory Services Group
Bureau of Reclamation
Denver, CO 80225
csvoboda@usbr.gov

Mike Horn
Research Aquatic Scientist
Fisheries and Wildlife Resources Group
Bureau of Reclamation
Denver, CO 80225
mhorn@usbr.gov

Summary

Federal and state fish screening facilities in the south Sacramento-San Joaquin Delta have been known to provide favorable habitat for predator fish, primarily striped bass *Morone saxatilis* (Gingras 1997, Bark *et al*. in draft). Predators tend to concentrate in and around fish screening facilities in zones where water velocities are lower (Bark *et al.* in draft*)*. At the Tracy Fish Collection Facility (TFCF), striped bass are frequently found residing upstream, downstream, and within the facility (Bark *et al.* in draft*)*. Striped bass are piscivorous fish that consume smaller fish and can reside within the TFCF year round feeding on seasonal influxes of entrained fish. Thus, striped bass can sustain a viable population within and near the facility as long as they have favorable environmental and feeding conditions (Bark *et al.* in draft*)*. According to the Reasonable and Prudent Alternative in the 2009 National Marine Fisheries Service Biological Opinion, by December 31, 2011, Reclamation shall complete studies to determine methods for removal of predators in the primary channel, using physical and non-physical removal methods (*e.g*., electricity, sound, light, CO_2), with the goal of reducing predation loss to 10 percent or less (National Marine Fisheries Service, 2009).

The goal of this study is to investigate the potential for using an electric crowder as a safe and effective way of deterring or preventing large predator fish from taking up residency in the primary channel of the TFCF. The primary principle of the electric crowder is to produce volitional downstream movement of fish through avoidance rather than immobilization to minimize harm to fish of all sizes. The target size class for predator removal is fish larger than 300 mm.

Large fish are more susceptible to the electrical field than smaller fish; however, the effects of the field on an individual can depend on the specific location of the fish in the field.

In FY10-11, laboratory tests were conducted at Reclamation's Hydraulics Laboratory in Denver, CO. A stationary laboratory tank was used to measure the amount of power required to produce various response levels for a predator species at the TFCF, striped bass, in the size range of 254–368 mm (mean 315 mm) fork length (FL). Response levels from twitch to taxis to tetanus were observed and documented for 26 fish during the experiments. A rolling DC electrical crowder was designed by an electrical engineer at the Technical Service Center in Denver, CO and installed in a 0.76-m-wide (30-in-wide) acrylic flume. Seven pairs of electrodes (10 gage copper wires) were attached to the flume sidewalls at 0.46 m (18 in) spacing. A Smith-Root electrofisher unit produced pulsed DC at specified electrical properties (peak voltage, pulse width, and frequency). The sequencer moved the pulsed DC field from the first two sets of electrodes to the next two sets, such that the field rolled downstream. The magnitude and extent of the electrical field was measured with a voltage gradient meter. An angled screen with a 15.2-cm-wide (6-in-wide) bypass was installed in the flume to determine if predators would voluntarily enter the bypass to avoid the electric field.

Researchers observed the response of 24 striped bass (285–590 mm FL) and 60 juvenile Chinook salmon or rainbow trout (88–108 mm FL) to a rolling electrical crowder in moving water at 0.46 and 0.76 m/s (1.5 and 2.5 ft/s). Study results show that fish can move directionally when exposed to an electrical stimulus if the first set of electrodes is installed as far upstream as possible in the channel and the electric field rolls downstream. Most striped bass swam quickly downstream to avoid the electric field. Upstream swimmers were typically moved downstream on a successive pass of the crowder. The electric field should roll slower than the channel water velocity so stunned fish can drift out of the electric field. Juvenile Chinook salmon and rainbow trout displayed muscle twitch when encountering the field, but were not affected enough to show avoidance of the field.

Striped bass response to the bypass depended greatly on the lighting conditions in the bypass. When the flume and bypass were both light or both dark, fish entered the bypass easily. When the flume was light and the bypass was dark, striped bass were reluctant to enter the bypass, often encountered the electric field several times before entering. Because of these results, it is recommended that a full-scale evaluation include a light inside the bypass entrance.

Additional testing was accomplished in a 2.74-m-wide (9-ft-wide) model flume to better represent the dimensions of the secondary channel at the TFCF. Electrodes

consisted of 1.9-cm-diameter (¾-in-diameter) aluminum poles at 2.44 m (8 ft) spacing. The behavior of 30 striped bass (400–590 mm TL) was observed and recorded in this model for proof-of-concept testing.

In FY12, laboratory results were presented at the Interagency Ecological Program workshop and a Tracy Technical Advisory Team meeting in April 2012. A final, peer-reviewed Tracy Series report will be published and submitted to regulatory agencies for review in FY12.

Problem Statement

In FY13, researchers will contact local and regional Reclamation safety officers to discuss human safety concerns relating to a field test in the secondary channel. A safety plan will be drafted. Permitting requirements for a field evaluation will be investigated. An initial proposal for field testing will be written in FY13. Funding is also desired for meetings, presentations, and teleconferences as needed.

Goals and Hypotheses

The goal of this work in FY13 is to begin preparing for a field evaluation in the secondary channel at the TFCF. The secondary channel field evaluation will occur after the installation of the secondary Hydrolox screens (installation currently scheduled for FY14). Researchers will also be available to discuss the electric crowder concept and laboratory results as the Tracy Series report is made available to other federal and state agencies.

Materials and Methods

Research in FY13 will consist primarily of discussions, meetings, and collaboration with Reclamation safety officers and other agencies.

Coordination and Collaboration

Researchers will contact local and regional Reclamation safety officers to discuss human safety concerns relating to a field test in the secondary channel. Researchers will contact permitting agencies to determine what steps need to be taken for a field evaluation.

Endangered Species Concerns

Discussions will be held with the US Fish and Wildlife Service, National Marine Fisheries Service and the State of California regarding permitting required for testing the electric crowder at the TFCF during a future period.

Dissemination of Results (Deliverables and Outcomes)

Investigators will prepare a draft safety plan and a proposal for the secondary field evaluation.

Literature Cited

Bark, R., B. Wu and W. Frizell**.** *In Draft. Sonic Tag Tracking Studies of Striped Bass Passage at the Tracy Fish Collection Facility.* Tracy Fish Collection Facility Studies, U.S. Bureau of Reclamation, Mid-Pacific Region and Denver Technical Service Center.

Gingras, M. 1997. Mark/Recapture Experiments at Clifton Court Forebay to Estimate Pre-Screening Loss to juvenile Fishes: 1976–1993. Interagency Ecological Program for the San Francisco Bay/Delta Estuary. Technical Report 55.

National Marine Fisheries Service. 2009. Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, Southwest Region. Long Beach, CA.

Sechrist, J., C. Hueth, and S. Hiebert. *In Draft. Electric Barrier Efficacy Test: Frenchtown Diversion, Frenchtown, Montana, 2007 and 2008.* Bureau of Reclamation, Technical Service Center, Denver, Colorado.

Smith-Root Inc, Barrier and Guidance Systems, www.smith-root.com